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UNITED STATES DEPARTMENT OF AGRICULTURE



DEPARTMENT BULLETIN No. 1491

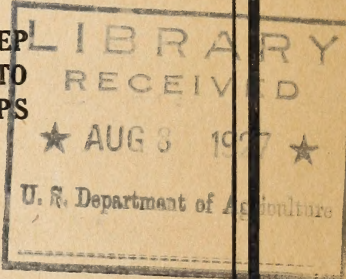


Washington, D. C.

May, 1927

TIMBER GROWING AND LOGGING PRACTICE IN THE CENTRAL HARDWOOD REGION

MEASURES NECESSARY TO KEEP
FOREST LAND PRODUCTIVE AND TO
PRODUCE FULL TIMBER CROPS



By

C. R. TILLOTSON, Forest Inspector, Forest Service

Introduction by

W. B. GREELEY, Forester, Forest Service



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INTRODUCTION

Forestry in the United States is no longer merely a theory or a subject for discussion; it has gotten down to concrete things in the woods. Nor is the growing of timber confined to public lands; it is gradually making headway on land in private ownership. It is becoming an art of land management, expressed in practical measures for protecting forest growth from fire and other destructive agencies, for logging timber so as to produce a new crop of wood, and for planting forest trees on cut-over or denuded areas. The value of timber, along with other economic considerations, is caus-

ing landowners more and more widely to study the possibility of profitable reforestation. These developments have created a general demand for information on the timber-growing methods which are adapted to the various types of forest growth in the United States, and on what these methods will cost.

Timber culture, like the growing of farm crops, is necessarily governed in any country by the soil and climate, by the requirements of the native forest trees, and by the national economic circumstances. Lessons may be drawn from the experience of other countries, as the United States has drawn upon the forestry practice of Europe, but profitable methods of growing timber, particularly under the wide range of forest types and economic conditions in the United States, can be evolved only from our own experience and investigation, region by region. Hence to meet the demand for information on practical ways and means of growing timber profitably in the various parts of the United States, it is important that the results of our own experience and investigation to date be brought together and set forth in the clearest possible way.

This the Forest Service has attempted to do in a series of publications dealing with the 12 principal forest regions of the United States. The information presented has been gathered from many different sources, including the experience, so far as it was obtainable, of landowners who have engaged in reforestation. An effort has been made to bring together all that any agency has yet learned or demonstrated about the growing of timber in the United States; and the results have been verified as far as possible by consultation with the forest industries, State foresters, and forest schools. These publications thus undertake to set forth, in a simple form, what are believed to be the soundest methods of reforestation as yet developed in our common experience and study in the United States.

Necessarily, the Forest Service claims no finality for the measures proposed. Timber growing in every country has come about through a gradual evolution in industrial methods and the use of land. All too little is yet known of the best methods of growing timber under American conditions. As time goes on, research and practical experience will add greatly to the success and certainty of the measures carried out in our woods, just as American agriculture has steadily become more highly developed or just as our manufacturing processes have been perfected through experience and study. But we know enough about growing timber now in the forest regions of the United States to go right ahead. Believing that the forest landowners of the United States are now ready to engage in timber growing on a large scale, the Forest Service has endeavored to place before them in concise terms the best suggestions and guides which the experience of this country to date affords.

In these publications the measures proposed for a particular forest region have been arranged in two general groups. The first includes the first steps, or the minimum measures based on local physical conditions, that are needed to prevent timber-bearing land from becoming barren. These measures, in which the prevention of fire is of outstanding importance, represent, broadly speaking, the least that must be done and the lowest cost that must be incurred to keep forest lands reasonably productive. While influenced in some cases by the

economic conditions in the region, they have been worked out primarily from the standpoint of the landowner who may not be ready to engage in real timber culture, but who wishes to prevent cut-over tracts unsuitable for any purpose except timber growing from becoming a liability on his hands. Except within certain limitations, which are discussed in dealing with particular regions, the Forest Service believes that these first steps or minimum measures should be speedily applied to all of the forest lands in the United States. And the service believes that public policy should encourage their universal application in such ways as protection from fire and the adjustment of forest taxation to the business of timber growing.

The second group of proposed measures constitutes what may be called the desirable forestry practice in the region concerned as far as our knowledge and experience to date enable us to determine it. These measures are designed to grow reasonably complete crops of the more valuable timber trees, making full use of the real productive capacity of the land. The recommendations are addressed primarily to the landowner who wishes to use his property up to its full earning power for timber culture. It is impossible to frame any general set of measures of this character that are adapted to the individual needs of particular holdings or industrial establishments. This is true particularly of forest regions like the Northeastern States, which include a great variety of local situations both in the types of growth and in economic circumstances. Hence, in presenting this group of suggested measures, the Forest Service has attempted only to draw the broad outlines of the more general and fundamental things, with illustrative methods of forest practice. The details of intensive forestry, like the details of intensive agriculture or engineering, call for expert survey in working out the plans and methods best adapted to a particular tract of land or a particular business. One of the most important features of expert planning for the management of a particular forest property or for a supply of raw material for a particular forest industry is to devise, not simply woods operations that will produce full crops of timber, but also a scheme of logging that will afford a continuous yield of products desired, in order that sustained earnings may be realized or a sustained supply of raw material made available.

In some cases it is not practicable to draw a hard and fast line between the first steps that will maintain some degree of productivity on forest land and the more intensive measures that will bring the quantity and quality of wood produced up more nearly to an ideal management. Graduations between the two general groups of measures are inevitable. The Forest Service has not attempted, therefore, to deal with the two general types of forest practice as wholly separate and distinct, but has rather endeavored to present a common-sense and practical résumé of the various steps in timber growing in the form that will be most helpful to the man in the woods. The bulletins have been written for the landowner and the lumberman rather than for the technical forester. Their purpose is to put the main ideas into the most useful form, considering the special needs and problems of each region, for aiding the man to whom timber growing is a concrete business and logging problem.

At the same time it is hoped that they will have a value for the everyday reader who is interested in forestry as an important phase of land use in the United States and in the public policies designed to bring forestry about.

It is impossible for publications necessarily dealing in broad terms with the conditions existing over large regions to attempt any brass-tack conclusions on the cost and returns of timber growing. The approximate cost of the measures advocated is indicated as far as practicable, and the extent to which they may be of benefit in connection with logging operations, but with no attempt to segregate the items chargeable to harvesting one crop of timber from those which should be regarded as invested in a following crop. Conservative estimates of the future yields of timber that may be expected under the various practices recommended are given where the facts available appear to warrant them; but no forecasts of the profits to be derived from commercial reforestation are attempted. The financial aspects of forestry can not be dealt with in general terms. Here again expert advice must deal with the situation and with the problems of the individual forest owner or manufacturer.

As a broad conclusion, however, with the exception of limited situations which are dealt with region by region, the Forest Service has tremendous faith in the commercial promise of timber growing to American landowners. The law of supply and demand is working steadily to create timber values which in large portions of the United States will pay fair returns on forestry as a business. The economic history of other countries which have passed through a cycle of virgin forest depletion similar to that which the United States is now traversing points to the same inevitable conclusion. The time is fast approaching when forestry, and forestry alone, will supply the enormous quantities of wood demanded by American markets. The fundamental laws of business must in the nature of things so operate as to enable the markets of forest products to be supplied at a profit to the grower of timber. The returns already being obtained from this form of land employment at many points in the eastern United States show plainly enough that this relationship between the value of timber and the cost of producing it is already coming about to a marked degree.

To the men who own forest-producing land in the United States or who are engaged in industries which require timber as raw material, forestry now offers a commercial opportunity. Satisfactory returns from forestry can not be promised in sweeping terms any more than returns from the manufacture of lumber or paper. But the opportunity for a profitable employment of capital and business talent in the growing of timber merits the same consideration and the same expert guidance as industrial opportunities in the conversion of timber. This applies with special force to the commercial institutions in the United States which have made large capital investments in manufacturing plants and distributing organizations, dependent for their maintenance upon a future supply of forest-grown material. It applies equally to the owners of land, in large tracts or farm wood lots, the earning capacity of which lies solely in the growing of trees and which, without tree growth, will become either a doubtful asset or an outright liability.

The Forest Service earnestly asks the forest landowners of the United States to determine for themselves, with the same care with which they would approach any other business problem, whether timber growing does not offer a commercial opportunity which should be grasped. It commends this series of publications to them, not as a complete or authoritative scheme that can forthwith be followed with profit in their own woods, but as a starting point in utilizing the opportunities that forestry may hold out.

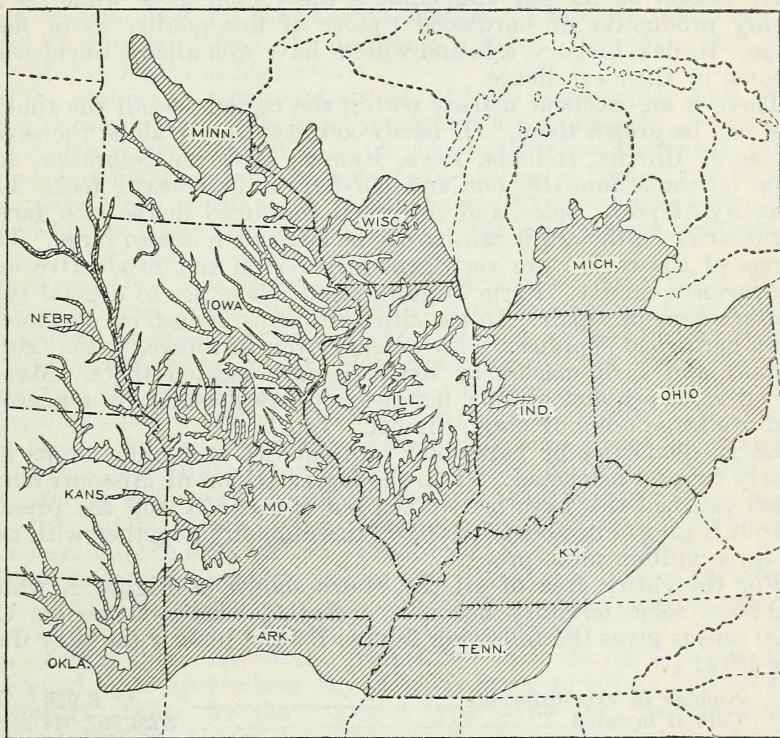


Fig. 1.—Central hardwood region

THE REGION AND ITS POSSIBILITIES¹

The Central hardwood region includes about 40,000,000 acres of woodland in Ohio, Indiana, Illinois, Iowa, and Missouri, the southern portions of Michigan, Wisconsin, and Minnesota, the eastern edge of Nebraska and Kansas, the northeastern corner of Oklahoma, northern Arkansas, and the western half of Kentucky and Tennessee. (Fig. 1.) As a forest region it differs greatly from other forest regions in the United States, in that three-fourths of the timber-producing acreage is in the form of farm wood lots, generally 10 to 40 acres in extent;

¹ The writer acknowledges with most sincere thanks the assistance in the collection of data for this bulletin which he received from State Foresters Edmund Secrest, of Ohio; Charles C. Deam, of Indiana; R. B. Miller, of Illinois; R. S. Maddox, of Tennessee; C. L. Harrington, of Wisconsin; G. M. Conzet, of Minnesota; Frederick Dunlap, of Missouri; from L. J. Young, of the University of Michigan at Ann Arbor, and E. G. Cheyney and J. P. Wentling, of the University of Minnesota. He wishes particularly to acknowledge help from Frederick Dunlap in the reading and criticism of the manuscript.

only one-fourth is in comparatively large tracts of practically continuous forest.

The unbroken or only slightly broken forest is found in the hilly sections, mainly on lands not well suited for farming, in southern Ohio, Illinois, and Indiana, the highland rim of Kentucky and Tennessee, and the Ozark Plateau in Missouri and Arkansas. The 30,000,000 acres in farm wood lots are scattered throughout the better-developed agricultural sections.

By reason of its soil and climate the region as a whole is as highly productive of hardwood timber of fine quality as of field crops. Its oak, hickory, ash, and walnut have won almost world-wide renown by their excellence.

There is an excellent market within the region for all the timber that can be grown there. Of hardwood saw timber alone the seven States of Illinois, Indiana, Iowa, Kansas, Missouri, Nebraska, and Ohio consume annually one and one-half billion board feet. The quantity of posts, poles, and cordwood consumed in the rich farming districts, although it can hardly be estimated, is also large. The farms of the region are very generally fertile and productive and the farmers thrifty. Farm buildings and fences are of a good type and are kept in repair. In the cities are many industries dependent upon hardwood supplies. The centers of the furniture, veneer, automobile, and farm-machinery industries are located there. Manufacturers of ash and hickory handles and oak flooring are numerous and are large users of native timber.

Large quantities of hardwood railroad ties and mine props are yearly cut and marketed. From the Ozark region of Missouri hardwood railroad ties have been taken out since 1850, and the present output is said to be about 10,000,000 ties annually, together with two or three million mine props.

For the entire area of all the States shown in Figure 1, which embraces some territory not in the central hardwood region, the 1920 census gives the following figures for the lumber industry during 1919:

Number of establishments.....	8, 926
Capital invested	\$526, 382, 044
Persons engaged	192, 147
Yearly salaries and wages.....	\$183, 555, 940
Taxes paid (Federal, State, county, and local)	\$15, 743, 098
Value of products.....	\$615, 274, 624

Agriculture and the mines, railroads, lumber manufactures, and other industries afford an ample market, and in some instances a very high-class market for all timber grown or that can be grown in the region.

TIMBER AND TIMBER TYPES

The present stands of timber in the central hardwood region are largely the culled remnants of former very fine hardwood forests. Continual cutting of the best species and individuals, forest fires, and the heavy pasturing of three-quarters or more of the smaller, fenced-in farm wood lots have rendered these stands for the most part badly dilapidated and decadent. Although here and there are tracts that have been well cared for and are in excellent condition,

the greater portion of the timber is on a slow but seemingly sure march to extinction and offers little promise for the better unless present practices are materially altered.

A few virgin stands are still in existence, generally individual pieces of timberland held off the market for personal reasons by the owners, or else stands relatively inaccessible. Their timber is characteristically uneven-aged and uneven-sized.

The remainder of the hardwood forests is in rather extensive stands of even-aged second growth that has come in where the virgin forest was cut clean for charcoal production. There are found especially in southern Ohio, the highland rim of Tennessee, and in parts of the Ozarks in Missouri.

In the number of hardwood species of high commercial value the region is exceptional. The most important are white oaks, red oaks, hard maple, silver maple, red maple, beech, the elms, basswood, yellow poplar, black walnut, butternut, the ashes, red gum, the hickories, river birch, cottonwood, tupelo, hackberry, sycamore, and willow. Shortleaf pine, scrub or Virginia pine, and eastern red cedar mix with the hardwoods in some sections.

Pure stands of any species seldom occur extensively. When cottonwood is found in pure or practically pure stands it is undergrown at maturity by other bottom-land species, such as soft maple, river birch, elm, ash, and pin oak. Characteristically the species occur in mixture, of which the composition varies with every hilltop or ridge, slope, flat, or bottom, and from one acre to another. At most, some one or several species have been or are numerically of enough importance over rather large areas to give their distinctive character to the forest, such as the maple and beech of northeastern Ohio, and the oaks and hickories of the Ozark region of Missouri, northern Arkansas, and the hilly section of southern Ohio and Indiana.

Tree species of aggressive habits and little value do not threaten seriously to take possession of cut-over lands, with the possible exception of ironwood here and there on restricted areas.

In general there are in the region two main forest types to be considered, especially where any effort is made to obtain full crops of timber. These are the "upland type" and the "bottom-land type." Under the upland type there is also a subtype, "mixed hardwoods and conifers."

As indicated by their names, the distinction between the two main types is based on topography and on soil moisture conditions. The upland type includes the areas of higher, well-drained soils; the bottom-land type is characteristic of the moister, lower levels of slow drainage, swamps, and periodic overflow. The two types are also fairly well differentiated by the tree species that compose them, the key species of the bottom-land type being red gum, cottonwood, river birch, cypress, willow oak, sycamore, willow, silver maple, overcup oak, and swamp white oak. The upland type is characterized less by key species than by the absence of the key species of the bottom land. Distinctive species are chestnut, chestnut oak, pignut hickory, post oak, blackjack oak, and shortleaf pine. Yellow poplar, white oak, sugar maple, black cherry, and the northern red oak are fairly distinctive but are also occasionally found in the bottom lands,

The old stands in the upland type, now mostly culled, are characterized when free from fire and grazing by 10 to 50 trees to the acre 14 or more inches in diameter and several times as many smaller trees, grading down to 1-inch saplings and an abundance of seedlings of various ages. The proportion of sizes and ages on different tracts varies greatly. The point to keep in mind is that on each acre of culled forest, except for occasional stands, there is not a very large quantity of saw timber (trees 14 or more inches in diameter) but almost invariably a many-aged stand of young growth coming in.

The mixed hardwood and conifer subtype is characterized by the admixture of shortleaf pine, or eastern red cedar, or to a very limited extent scrub pine, and is found in the hilly sections of southern Ohio and Indiana, and in Kentucky, Tennessee, Missouri, and Arkansas. It is best typified by the shortleaf pine-oak-hickory mixture of the Ozark country of Missouri and northern Arkansas. Aside from the admixture of conifers, the subtype does not differ materially in general characteristics from the oak-hickory upland stands. Where shortleaf pine occurs, however, it appears to be on the increase and, given the necessary encouragement, tending eventually to supplant hardwoods at least on south and west slopes. The pine is a superior tree to its companion hardwoods both in growth and in freedom from defect. It is not materially harmed by the light grazing of this region, it appears less affected than hardwoods by disease and insect injury, and in common with hardwoods it has in youth the capacity to sprout after fires.

Mature stands in the bottom-land type are characterized by a greater number of trees to the acre 14 or more inches in diameter than on the uplands, the total generally varying from 50 to 100. Typically, the crown cover is dense, saplings and small poles 1 to 5 inches in diameter are not usually numerous, and seedlings 1 to 4 years old are often present in great numbers, particularly if fires have not recently passed over the ground. It appears that seedlings under the dense shade obtaining manage to survive for several years, die out, and are replaced by a new crop. The point to remember here is that seedlings in considerable numbers (some counts have shown 100 per square rod) are present and ready to develop when the overtopping trees are cut. In addition, forest tree seed of some species, such as green ash and red gum, appears to remain dormant in the surface soil or leaf mold of this type and to retain its capacity to germinate and grow vigorously after the old trees are cut. Vines, both of the woody and herbaceous types, are present over restricted areas to such an extent as to cause real damage, the larger vines weighing down and choking out older timber and the smaller over-coming seedlings and saplings. From Tennessee south, cane springs up on some of the bottoms after logging and may prevent or retard the growth of seedlings.

EFFECT OF TIMBER-CUTTING OPERATIONS

Although timber has been cut in the region for 75 years or more, the cutting has hardly assumed the proportions of logging operations as generally understood, save in a comparatively small territory.

Rather, the process at first was to pick out and fall a few of the largest and best trees of the most valuable species, such as black cherry, yellow poplar, white oak, or black walnut for furniture or stave manufacture, or other specific purposes. Often only 5 to 10 trees were taken from an acre, and some acres devoid of large trees were untouched. Later the small sizes of these same species or the best trees of other species were taken. Occasionally nearly all trees of merchantable size and quality were cut.

In most instances logging was conducted by animal power, and forest conditions were not badly disturbed. If grazing did not follow cutting, the openings created by the operation were quickly filled by young growth, and the stand soon became as dense as it was before.

In the woods this system has brought about a steady decrease in the proportion of best species in the older timber. The selection or culling out of the best trees, continued down to the present day, has resulted in a very large area of farm woods whose present mature growth is composed of species of little commercial value, together with broken, decayed, limby, and crooked trees of the better species. If this selective type of cutting continues and if the area is also grazed, the farm woods will slowly but surely be eliminated as a source of any great amount of timber for the general market or even for use on the farm.

In larger operations, other than those for charcoal manufacture or for the avowed purpose of clearing land, selective cutting has almost invariably left standing a considerable number of undesirable trees large enough to bear seed and to scatter it over the cut-over land. These are crooked, stunted, defective, limby trees, or trees too small, or otherwise not commercially valuable. Naturally, they embrace a greater proportion of the least valuable species. Although it may pay at the time to fall a large, defective white oak which will yield one log or tie, it will not pay to fall an equally defective black oak containing the same volume of less valuable material. Usually, therefore, the trees left standing to reclothe the land do not include a satisfactory proportion of the more valuable species.

There are always trees in rather favorable open situations which bear and scatter seed at an early age. In consequence, seedlings, often inconspicuous, are nearly always present under the old timber before it is cut, ready to grow vigorously after logging has been discontinued. When, as often happens, several hundred or a thousand forest tree seedlings or saplings to the acre are already present on the ground, or are practically certain to come in after logging, the lands would be in better condition for growing timber if the defective, old, stunted, and limby trees were removed. Not only are these unlikely to develop into valuable timber themselves, but their presence interferes with the development of the seedlings and saplings that spring up, and so decreases the final yield of timber.

On areas cut at one time for charcoal, as in parts of Missouri, Tennessee, and Ohio, where the operations took practically everything, occasional large trees and small saplings escaped the ax. Reproduction from seed and sprouts invariably followed in spite of the subsequent fires that were fully as much the rule in the old days as in the present. Many fine young pole stands exist to-day in proof of this.

Logging can be expected to continue on a rather intensive scale on the large holdings in the alluvial bottoms of the Ohio and Mississippi River drainage until the valuable mature timber is cut out, but will probably not be followed by any extensive timber growing. For the most part, the land is very rich and is rapidly being leveed and ditched and opened up by good roads. The improvements have made taxes high, and, in spite of some difficulties and drawbacks which attend the development of these lowlands, it seems inevitable that for the most part they will be farmed. Timber produced on them in the future will, as a rule, come from small farm woods similar to those in the uplands.

In the mixed hardwood-conifer type, the conifers are ordinarily cut to a smaller diameter than the associated hardwoods because they are less defective and size for size yield more per tree. Insufficient conifers are thus likely to be left for seed trees. Commonly, however, there is in the stand considerable young coniferous growth too small for cutting. If not destroyed by the logging operation, it will form a part of the next crop. If young conifer growth is scarce and no old conifer seed trees are left in the logging operations, hardwoods will take possession of the ground.

All too commonly, little or no care is exercised in logging operations to avoid breaking and rendering worthless young and vigorous timber of pole and sapling size and of considerable potential value. The stumps of sound timber, moreover, are frequently cut unnecessarily high. Both practices involve in the aggregate a tremendous and needless waste, which could be greatly lessened by insistence on the part of the operators that the practices cease. It would work no hardship on the operators, cost them nothing more than a little closer supervision of logging operations, and mean money in their pockets in the end.

Although the cutting of timber in this region has not been conducted with the idea of perpetuating the timber crop, the net effect of the operations is rather to deplete or lower the value of the stand than to devastate the region in the sense of making it hopeless for a future natural growth of timber. Barring constantly recurring fires and concentrated grazing by livestock, most of the cut-over lands of this region will come back, and rather quickly, to a second growth of which commercial timber species will form a large proportion.

FACTORS UNFAVORABLE TO CONTINUOUS FOREST CROPS

DOMINANCE OF THE AGRICULTURAL CROP IDEA

For the most part, the use of the land is controlled by agricultural interests whose dominating idea is the production of the ordinary farm crops, as wheat, corn, oats, potatoes, and hay. Much of the agricultural land in the region was developed through the laborious process of clearing it of timber. Although the need for clearing has largely passed, the belief persists that the land should be devoted to agricultural crops and to grazing. In the better farming portion of the region, moreover, the value of the land is high and the taxes on timberland nearly, if not fully, as burdensome as on cleared land. The owner accordingly feels obliged to operate

the farm the best he knows how to obtain the largest cash return each year.

On good soils, it is true, the value of timber growth in a year is not equal to that of most agricultural crops. Estimates of men familiar with the region make it appear improbable that the average growth of timber per acre on the very best alluvial bottom-land soil and in stands fully stocked with trees exceeds 500 or 600 board feet per year. Unfortunately, authentic comprehensive figures bearing on this are lacking. On the poorest uplands, annual growth probably does not exceed 100 board feet per acre; on soils of intermediate quality, it will probably lie between 200 and 400 board feet. If growth in some cases considerably exceeds 600 feet an acre a year it will be on bottom lands in stands running heavily to cottonwood, red gum, or soft maple.

The prices paid for timber on the stump ordinarily range from \$3 a thousand feet to \$50 or more. The best specimens of black walnut, old virgin high-quality growth, command much higher prices. Second-growth white ash and hickory suitable for handle stock commonly bring \$25 to \$40 on the stump. Old-growth yellow poplar and white oak suitable for veneer or quarter-sawing often sell for \$25, \$30, or more on the stump. For mixed hardwoods—everything in the stand of timber—buyers rarely pay more than \$10 to \$15 per 1,000 feet and usually less.

Using these stumpage values and the foregoing figures of growth as a basis for calculations, it can be seen that the yearly value of timber growth on an acre will vary considerably. On the poorer upland soils where the timber is rather small, scrubby, and consists mostly of oak and slow-growing hickory, the stumpage value of the yearly growth of fully stocked stands would probably not be over 30 to 50 cents an acre. On better soils it would vary between \$2 and \$6, and if the stand were largely second-growth white ash, or a mixture of thrifty clear white oak, yellow poplar, and black walnut, it might range from \$4 to as much as \$16 a year.

These returns do not represent an average for the region because the timberlands, except in a very small percentage of instances, are not bearing a full crop of trees; they are not bearing half a crop. The farm wood-lot owner has not been taught to consider his woods as a crop; he has not thought of how desirable from his own financial standpoint it is to have his woods fully stocked with trees as he wants his cornfields to be fully planted without gaps. He does not know how to increase the percentage of more valuable species in the stand and finally how and where to market the timber to the greatest advantage. He is not, accordingly, realizing on its full possibilities as a revenue producer, and if he gives it any thought at all doubtless feels justified in permitting the woods to die out gradually and be superseded by pasture land and plowed fields.

While the returns indicated are not equal to those ordinarily obtained from agricultural crops on good soils, it should be remembered that these figures are based on the product as it stands in the woods before cutting and hauling to a market. If the returns were to be compared with those from a crop of corn, the value of the corn should be figured as it stands in the field before it is picked. Further, it

should not be forgotten that the wood crop has been produced without the labor of plowing, harrowing, planting, and cultivating that attends the growing of corn.

PASTURING THE WOODS

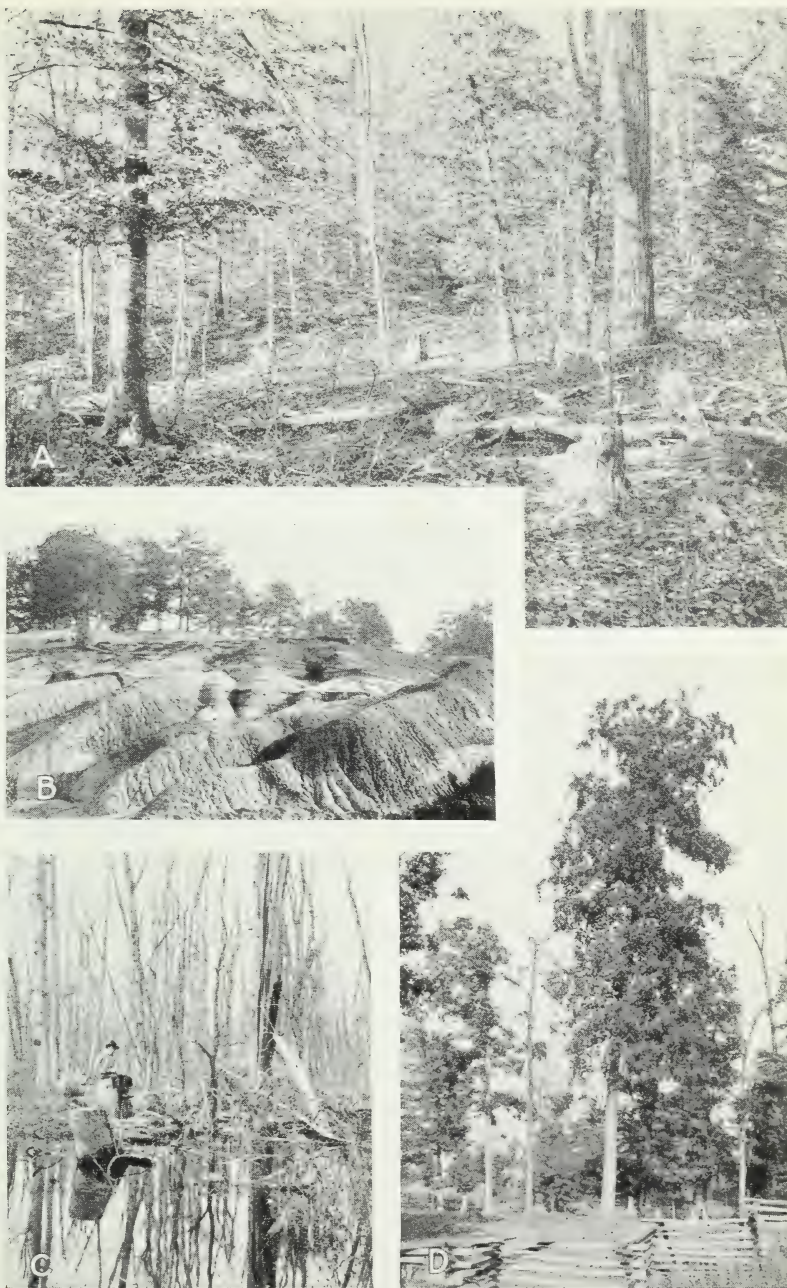
It is common practice in this central hardwood region to turn livestock into the woods. Probably 75 per cent of the small farm woods are heavily pastured. They offer a small quantity of browse for cattle, horses, sheep, and goats; and nuts, acorns, various roots and bulbs, and grubs for hogs. In addition to food, the woods afford shelter from sun, wind, and storm.

Nearly all hardwoods are subject to browsing by stock. Elm, ash, maple, basswood, and yellow poplar appear especially palatable; hickory, the oaks, cottonwood, willow, and red gum are less relished. Stock can be starved into eating almost any kind of hardwood reproduction. The damage is worse in the spring of the year when the growth is tender and grass has barely started, and during hot, dry summer spells when the grass is dried up. Hogs are partial to beech-nuts and to the acorns of the white oaks, but in the absence of these, devour the acorns of red oaks. Where hogs run in the woods the chances for white oak and beech seedling reproduction are considerably lessened.

When the livestock are numerous and are concentrated in woods of a relatively small area, as in most of the small farm wood lots, the result is always the same. The young growth is eaten, broken, stripped of bark, bent, or tramped out, and new growth does not take its place. Grasses work into the woods from the edges and in the small openings. The older trees gradually die in the tops and are then usually cut out by their owners. The result is a gradual transformation from a rather dense woods to a wooded pasture in which the trees continue to die off and decrease in number from year to year. This means the gradual elimination of the farm woods.

The custom of pasturing the woods is pretty well fixed. It is the biggest obstacle to the natural regeneration of timber in the small isolated farm woods of the region. In those parts of the central hardwood region where the timber covers extensive areas, fences are commonly lacking and livestock is not so numerous, runs at large, and does little damage except where it concentrates near the villages, along roads, or along streams. Indirectly, however, it is responsible for many of the forest fires which regularly sweep over these lands, some owners of livestock setting fires because they believe burning improves the range.

Judging from the estimates of farmers and others in the region, the forage value per acre of the farm woods varies from 25 cents to \$1.25 a year. This is largely predicated upon the number of acres which it takes to support a cow and varies, of course, with the density of the woods. It has been estimated by Ovid A. Alderman, assistant forester of Ohio, that 2 acres of common farm pasture and 1 acre of woods will support a cow and a suckling calf during a five-month grazing season and that the cow if only fairly fat to begin with will gain 80 pounds and the calf 75 pounds. Figuring this increase at a value of \$10 per hundred pounds gives a total of \$15.50.



PASTURING AND BAD MANAGEMENT PREVENT PROFITABLE TREE CROPS

Land culled of its best growth (A) or bereft of all profitable timber (C) must now be cut off clean if the profitable species are to have a chance to grow. Continued heavy pasturing slowly but surely eliminates the woodlot, as in these Indiana farm woods (D) or the pastured and eroded land in Southern Ohio (B). Planted and protected from livestock, however, such areas can become a source of steady and increasing revenue



PROTECT PROMISING FOREST LAND FROM LIVESTOCK AND FIRE

Stop burning the woods, and the "brush" now coming up (A) will become valuable timber. Keep livestock out of thrifty upland forest (B), where protection has already developed a wide range of sizes, and not only will there be a profitable crop of timber, but an abundance of small trees will be ready to fill in spaces and renew the stand when the large trees are cut

He states that where fattening cows are allowed to graze through a good woods adjacent to a good pasture they will take less than one-tenth of their food from the woods. On that basis, the value of 1 acre of woods pasture is \$1.55.

Chapman and Miller have shown² that the stumpage value of the products being taken from an acre of the average Illinois wood lot each year is \$1.69, and that these products bring \$4.76 or nearly three times as much when sold. The \$1.55 worth of meat put on by the cow and calf is the sale value of the produce and it should, accordingly, be compared with \$4.76, the sale value of the forest products. The value of the latter is more than three times that of the former. This \$4.76 represents the value of 40.4 cubic feet of wood products taken yearly from the average acre of farm wood lot in Illinois. This is no more than the average wood lot well stocked with trees and efficiently managed could be expected to produce every year.

The value of the products naturally varies somewhat in different parts of this region. It seems obvious, however, that the value of the wood the farm woods can produce each year is several times the value of the forage. Where pasturing of the woods is heavy, it means practically no net growth of timber and a growth of forage only a fraction as good as that of open pastures, something that nobody wants. It is better from the pasture standpoint to clear the land of timber and better from the timber standpoint to eliminate heavy pasturing.

FOREST FIRES

Where timber occurs over extensive areas, forest fires are prevalent and periodically burn over a wide territory. They are a seriously unfavorable factor there. Many are set to improve the range, others to kill snakes and ticks and other insects and to drive out the wolves. The snakes, the ticks and other insects, and the wolves still persist after a half century or so of burning, and meanwhile the fires not only reduce the final yield materially by thinning out the timber but are responsible also for an average loss from defect in timber of merchantable size that has been estimated by several lumbermen in the region at 20 to 33 per cent. From 50 to 90 per cent of the saplings and poles in these periodically burned areas are fire scarred. If they reach maturity, they are certain to be seriously defective because of rot or insects which enter through the fire-caused wounds.

An inspection of 207 stumps taken at random on one logging operation in southern Tennessee showed the following percentage of hollow or rotten centers:

Yellow poplar.....	92	Post oak.....	100
Black oak.....	57	Hickory.....	80
Chestnut.....	84	Chestnut oak.....	62
White oak.....	58	Shortleaf pine.....	17

In addition to being hollow or rotten, many of the butt logs, particularly of black oak, were wormy. Many of the trees had to be butted off 8 to 12 feet, and some were almost valueless. The logging superintendent was authority for the statement that the tract had not cut more than 50 per cent of what it had been estimated to yield.

² CHAPMAN, HERMAN H., and MILLER, ROBERT B. SECOND REPORT ON A FOREST SURVEY OF ILLINOIS, THE ECONOMICS OF FORESTRY IN THE STATE. State of Ill. Nat. Hist. Surv. Bul., Vol. XV, Article III, p. 158, 1924.

Another serious but little realized effect of these fires is that they commonly kill back to the ground the young sprouts and seedlings a few inches to a few feet high, locally called "brush." Too commonly this small brush is looked upon locally as valueless, as a detriment to the land, and as something which should be destroyed by fire. In consequence, it is burned periodically every few years when it begins to form a dense thicket. Although a big proportion of this brush will resprout, even a single burn sets it back several years on the road to merchantable size and a profitable return to the owner 50 to 100 years hence. Several burnings still further defer the possibility of a timber crop. The development of a local appreciation of the potential value of this young growth and the desirability of protecting it from fire is the outstanding timber problem of this part of the region.

In the small isolated farm woods fire danger is practically negligible. Occasional small fires occur but these can not spread far and do little damage in the aggregate. Moreover, public sentiment in the region is opposed to fires on farm woodlands, and this is a most effective deterrent.

FACTORS FAVORABLE TO CONTINUOUS FOREST CROPS

TENDENCY OF THE REGION TOWARD NATURAL REFORESTATION

The simplicity of the measures to be discussed later for keeping the forest land productive is not easily understood unless there is some recognition of the remarkable recuperative powers of the hardwood forests. It truly seems that in the central hardwood region nature has provided against every possibility that might make forest land nonproductive.

Nearly all species sprout well from the stump if cut in the seedling or sapling stage, and in such instances a second crop is assured. Even after fires have killed the tops back to the ground, young growth will sprout. The oaks and hickories are especially persistent sprouters after fire, and retain this vigorous sprouting capacity to 40 or 50 years of age. This quality is particularly valuable in such bad fire regions as the Ozarks, the southern portions of Ohio, Indiana, and Illinois, and on the highland rim of Tennessee and Kentucky, where oaks and hickories are the characteristic growth. Other good sprouters up to a stump diameter of 8 to 12 inches are silver maple, paper birch, river birch, ash, sycamore, and black willow.

In addition to the sprouting capacity of all young growth, the seeding habits and ease of reproduction from seed of many of the species also make for continuously productive stands of timber. Consideration of some of these traits will serve to explain the composition of many of the second-growth stands of the region.

The ability of the maples and ashes, and even of elm in its youth, to grow in the shade enables these species to start under old stands and thus be in occupancy of the ground and ready to spring up quickly after the old timber is cut. The wide distribution of these species in the central hardwood region and the ease with which their seed can be disseminated is commonly making them, particularly the maples, a substantial component part of the young stands.

The oaks and hickories reproduce well by seed under fairly open old stands. Six to eight inch trees are often heavy seed bearers. As seedlings they withstand considerable shade. On sites where oak and hickory predominate, seedlings of hickory are often the most numerous of all advance reproduction in the stand.

Red gum seedlings are seldom found in quantity under old stands. When old stands made up of a good proportion of red gum are cut, however, the seedlings spring up in abundance. It appears that the seed lies dormant in the fallen leaves and surface soil and sprouts promptly when the old trees are cut. Red gum also reproduces to some extent from root suckers.

Ash seed apparently has the property of retaining its vitality for several years when lying on the leaf-covered ground of the forest. At least this seems the most logical explanation of the great abundance of young ash trees on many cut-over areas, especially as ash produces heavy crops of seed only at intervals of several years.

Some trees native to the region, cottonwood, willow, silver maple, river birch, and the elms, ripen and scatter their seed in the spring or early summer. This is disseminated partly by the wind and partly by the streams which carry it away at flood and later deposit it in situations suitable for germination and development. The Mississippi River is at times fairly green with seed of one or more of these species. Such seed germinates the same season and clothes the land with small trees. Species ripening their seed in the fall may germinate at that time if weather conditions are favorable or may hold over until the following spring. There is thus a double prospect each year of a new crop of trees from seed.

Beech and cypress are reproducing very little and apparently will eventually disappear from the stands of the central hardwood region. Beech might do better if hogs were generally eliminated from the stands. Beech reproduced from root sprouts does not develop well.

In the Missouri Ozarks, old shortleaf pine trees 7 or 8 inches in diameter and 25 to 40 feet tall, left in logging operations as suppressed and worthless, are bearing seed and effecting ample reproduction within a radius of several times their height.

A herbaceous ground cover of heavy grass will seldom prevent hardwood seedlings from establishing themselves. Elm in particular invades such areas and is followed closely by ash, hickory, black cherry, and maple. On the bottoms reproduction is seldom found on areas densely clothed by the great nettle and poison oak, but these occur only as small patches here and there.

MUCH LAND PRIMARILY SUITED TO TIMBER PRODUCTION

Although over a large proportion of this region the land is admirably suited to general agricultural pursuits, this is not true everywhere. In many of the hilly and sparsely settled counties the acreage of improved land in farms and the actual number of farmers was less in 1920 than in 1910. Some of the land is too far from railroads or even from good highways for profitable farming. Nor has fruit growing had any pronounced success in all the places where it has been tried out. Because of rough topography and stony character 10,000,000 acres in the Missouri Ozarks, mostly in the east-

ern part, has been classed by the Missouri Soil Survey³ as suitable only for timberland or woodland pasture, and in one county only 10 per cent of the land is regarded as arable. In Illinois the State Soil Survey⁴ has classified 6,000,000 acres of land as suitable only for pasture or forest.

These hilly counties are already supporting a woods growth over a large part of their area and the indications are that, for the present at least, wood is the best crop to grow. Some large areas of this hill land are owned by tie operators, lumber companies, and mining companies, some of whom have worked the land over for timber several times. Not much is being sold for agriculture, principally because there is no demand for it. If not disposed of quickly after the forest is cut off, it comes back to a young growth of timber or brush which makes it unattractive to any prospective farmer. Apparently a good many million acres of this type of land is better suited for timber than for any other crop and will continue in forest.

FARM WOODS FIT INTO PLAN OF FARM MANAGEMENT

A farm woods has a definite place in the management of every farm except perhaps the farm of small acreage devoted to truck crops. Valuable hardwood species are numerous throughout the region. They possess excellent qualities for a wide variety of purposes, and they are growing increasingly valuable and finding a ready market. The value of timber on the stump has on the average doubled in the last 12 or 15 years, and it seems likely that this increase in value, at least for timber of high quality, will continue. These facts will favor the continued growing of timber in the farm woods of this region.

Every farm owner has need during the year for material that can be grown in his farm woods, whether it be fuel wood, posts, hewn timbers, or lumber for repairing or building a shed or house. Census figures for 1919 covering the entire area of all the States of this region show 733,116 farms reporting forest products valued at \$72,667,357 used or cut and held for use on the farm. This averages \$99 worth to the farm. The farmer also often finds the need of selling timber products for ready cash. In 1919, 215,417 farms sold or cut and held for sale forest products valued at \$66,446,128, an average of \$308 to the farm. Fuel wood is also an important item on the farm. Where wood is the only fuel burned, 15 to 25 cords are needed annually for the average comfortably maintained farmhouse. If purchased, this would cost \$5 or more a cord.

The number of wooden posts used each year varies, of course, with the number of rods of fencing and the kinds of wood available. For the district covered by this report Osage orange posts have been known to last 35 years or more; black locust, red mulberry, and red cedar, 25 years and often longer; catalpa, 15 to 20 years; northern white cedar, 12 to 15 years; the white oaks, 10 to 12 years; the ashes, maples,

³ MISSOURI STATE BOARD OF AGRICULTURE. 53D ANNUAL REPORT (1921), pp. 275, 337, 401, 429, 430.

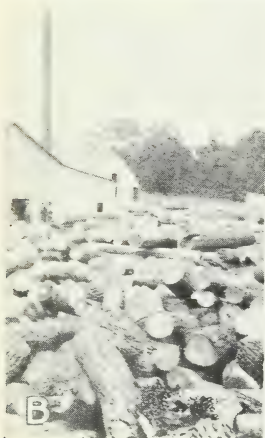
MISSOURI STATE BOARD OF AGRICULTURE. 56TH ANNUAL REPORT (1924), pp. 196, 418.

⁴ CHAPMAN, HERMAN H., and MILLER, ROBERT B. SECOND REPORT ON A FOREST SURVEY OF ILLINOIS. THE ECONOMICS OF FORESTRY IN THE STATE. State of Ill. Nat. Hist. Surv. Bul., Vol. XV, Article III, pp. 122 and 123. 1924.



GOOD TIMBER AND LOTS OF IT

(A) A stand of 50-year-old shortleaf pine, the very best tree for south slopes in the Ozarks. (B) A valuable young stand in Ohio that shows the results of good management. The poor trees have been cut for fuel and a bountiful crop of the best timber results. (C) This fine second crop of white oak is the result of clear-cutting for charcoal 50 years ago



THE HARDWOOD REGION YIELDS VALUABLE FOREST PRODUCTS

Railroad ties (A) and staves to be made from elm and other woods (B) are hardly less important products of the region than the fine cabinet work and veneer that the extremely abundant and valuable black walnut (C) is used for. White oak logs of large size and first quality (D) are very valuable for quarter-sawing and veneer.

cottonwood, and willow, 2 to 5 years. On the average, about two-thirds of a post for each acre of farm is needed for renewals each year. If a farmer is fortunate enough to possess such post timber as Osage orange, black locust, or red cedar, he will need less posts; if, on the other hand, he is obliged to use soft maple or cottonwoods, he will need more. If purchased, these posts will cost 15 to 50 cents or more apiece.

The average quantity of lumber used annually on farms has been estimated conservatively at 1,000 board feet. It varies greatly with the current prosperity of the farmer. Regardless of how much is used, it has a value of at least \$50 a thousand feet, based on its cost if purchased. An additional item of saving to be considered is that of horse and man labor needed in hauling purchased lumber or other wood products.

The advantage of owning timber is not wholly measured, however, by the actual saving in cash to the woods owner. A home supply of material will often mean that necessary repairs will be made when needed and the farm operations kept up to a high standard of efficiency; if the material were available only by purchase, repairs and new construction would be put off during hard times, to the deterioration of the farm and the lowering of its value.

The value of a farm woods is partly measured also by the protection against inclement weather which it affords to the farm buildings, orchards, crops, and livestock. This is evidenced in parts of the region where the woods are scarce. There has, in fact, been considerable planting of forest trees for the express purpose of protection and some for the prevention of soil erosion on hillsides. Although turning livestock into the woods for pasture has been the chief reason for the deterioration of small farm wood lots, it is still true that livestock, both in summer and winter, need protection such as the woods afford and that this has a definite, if unestimated, effect upon the animal and the quantity of milk or meat produced. It is not necessary, however, to give the stock the run of the woods. A sensible practice is to fence off 2 or 3 acres for shelter and reserve the rest for intensive production of timber.

Owners of farm woods have frequently stated that they would make more from their land if it were cleared of timber and devoted to farm crops, and yet they realize the value of home-grown timber at small cost readily available when needed. Although farm woods are decreasing in area in portions of the region, this is in general due more to gradual attrition through grazing than to deliberate clearing for tillage. There is some clearing in the bottom lands of the Mississippi River and its tributaries where new farms are being created on some of the lands recently logged.

One of the factors most favorable to continuous timber production in this area is that such a large proportion of the timbered area is owned by the small farmer who, although not now doing so, can and will, if he becomes interested, tend and develop his woods just as diligently as his other farm crops with attendant results in growth and yield that will be extremely gratifying. Further, if the woods are handled as one of the definite farm crops, they will provide labor

for both men and horses during the winter and early spring when there might be little other work to keep them employed.

FAVORABLE TAX LAWS

Three States, Indiana, Ohio, and Michigan, have passed timber tax laws very favorable to the timber owner. Indiana's law provides for assessing at \$1 an acre timberlands which meet certain requirements. Native forest lands must bear at least 1,000 trees of timber species an acre, and grazing by livestock is not allowed. The law of Ohio provides for assessing the timberland at 50 per cent of the local rate for similar land not bearing timber growth, either mature or immature. When forest products are cut for sale, they are subject to a tax of 5 per cent of their gross stumpage value. The law of Michigan provides for private forest reservations which are assessed on a nominal valuation of \$1 an acre and are subject to a yield tax of 5 per cent on the appraised stumpage value of the trees when cut. Grazing is prohibited in these reservations. A second Michigan law for commercial forest reserves excepts suitably qualified and classified lands from the property tax entirely. The owner must, however, pay an annual tax of 5 cents an acre on softwood lands and 10 cents an acre on hardwood lands, and in addition must pay a yield tax of 25 per cent on the value of any timber cut. The State pays 5 cents an acre annually to the county wherein such lands are situated.

Other States have passed tax exemption or bounty laws to cover land planted to timber trees. On land not worth more than \$10 an acre and planted to forest trees, Wisconsin provides for complete exemption from taxation for 30 years. Minnesota grants a bounty on forest tree plantations of \$2.50 an acre a year for a period of six years but not exceeding \$25 in any one year. Illinois counties are authorized by State law to offer to any person in the county who plants 1 or more acres of land to forest trees and properly cultivates them for three years any sum not to exceed \$10 per annum for three years for each acre planted and cultivated. Kansas counties may offer \$10 an acre a year for five years. In Iowa, taxes on forest-tree plantations are levied on a nominal valuation of \$1 an acre for an indefinite period, when certain cultural conditions are fulfilled by the plantation owner. Kansas and Nebraska laws prohibit increasing the assessed valuation of land when planted to trees.

STATE AND FEDERAL AID IN PROTECTION AGAINST FOREST FIRES

In Ohio, Kentucky, Tennessee, Missouri, Oklahoma, Minnesota, Wisconsin, and Michigan, State and Federal aid is provided in the protection of forest lands against fire. Although such protection is not entirely effective as yet, it is becoming more so each year and eventually will make all timberland reasonably safe from fire. The Federal Government has embarked upon a definite policy eventually to bear one-fourth of the expense of protecting State and privately owned timberlands against fire. Table 1 indicates the acreage of forest land needing protection, amounts which need to be

spent to give it adequate protection against fires, and the amount now being expended by State, private, and Federal agencies:

TABLE 1.—*Extent and cost of adequate fire control on State and private timberlands in the central hardwood region, with amounts expended in 1925*

States	Forest land needing protection	Estimated yearly cost of full protection	Amounts expended in 1925		
			By State and private agencies	By Federal Government	Total
	<i>Acres</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Michigan ¹	3,300,000	58,500	43,900	4,500	48,400
Wisconsin ¹	5,650,000	91,800	10,900	5,700	16,600
Minnesota ¹	4,700,000	41,500	11,900	1,900	13,800
Ohio.....	1,100,000	27,800	10,797	1,882	12,679
Indiana ²	1,000,000	20,000			
Illinois ²	500,000	10,000			
Kentucky.....	9,000,000	225,000	6,125	1,868	7,993
Tennessee.....	10,000,000	250,000	³ 14,602	14,603	29,205
Missouri ²	13,000,000	260,000			
Arkansas ²	20,500,000	461,250			

¹ Approximate figures for farm wood-lot areas in southern part of the State falling within the central hardwood region.

² Did not cooperate with Federal Government in fire control in 1925; hence figures not available.

³ State expenditure only.

MEASURES NECESSARY TO KEEP FOREST LAND PRODUCTIVE

The wooded area of this region will, if undisturbed, keep on producing timber indefinitely through sprouts or self-sown seed, requiring no cultural measures other than the exclusion of agencies destructive to tree life. Lumbering operations do not destroy these reproductive possibilities. Harvesting is an essential feature of the production of the timber as a crop. Logging disrupts the stand, often does more damage than is necessary to young growth not yet ready to be harvested, and may bring about considerable changes in the composition of the stand, but it does not render the land unproductive. Past cuttings, clear and partial, indicate conclusively that ample young tree growth, either of seedling or sprout origin, will follow cutting operations and that the species will be the same as those in the stand cut over, although often in materially different ratios.

IN THE SMALL FARM WOODS

In the small isolated farm woods of this region, the only factor of material consequence operating against continuous forest production is the practice of pasturing the woods heavily with livestock. The measure necessary to keep such land productive is to exclude livestock from the woods, preferably all the time. If this is done even the very badly run down wood lots bearing only a few old scraggly trees to the acre will ordinarily seed in to young trees in three to seven years. After the young trees have reached a diameter of 4 or 5 inches, which will ordinarily be in 20 to 25 years, livestock can be allowed in the woods until the stand begins to thin out naturally or openings are again made by cutting. Even then it is not recommended that livestock have the free run of the entire woods. There is always valuable younger growth which they will damage.

It is far better to fence off 2 or 3 acres of the woods where they can run at will and exclude stock from the remainder.

ON FOREST AREAS

PUBLIC MEASURES

On the larger continuous forest areas grazing is not usually a serious factor except as the owners of livestock are sometimes prone to set fire to the woods. If grazing should develop in intensity to the point that it harms the timber, it should be curtailed.

At present the problem of keeping this forest land productive is purely one of fire prevention. Absolute fire prevention should be sought. The term "absolute" is used in the full knowledge that it will be practically impossible to attain. Nevertheless it is the goal which should be set for achievement.

This problem of preventing and suppressing forest fires is not a new one. A good many States have been wrestling with it for years, and systems of increasing efficiency have been built up which embody, in the main, the following features:

1. A central State administrative organization which is the directing force behind all State effort in forest-fire prevention and suppression. It is responsible not only for the administration of the forest-fire organization but for the preparation and publication of reports, educational pamphlets, newspaper articles, public speeches, etc., all designed to educate the public against carelessness with fire in the forest and of primary importance in combating the forest-fire evil.

2. Division of the State into districts not exceeding 500,000 acres in size, each in charge of a fire chief. These districts are divided into smaller districts of 20,000 or 25,000 acres, each in charge of one man, ordinarily called the fire warden, supported by several deputy wardens.

The duty of the fire chief is to keep in intimate and constant touch with the firewarden organization, to assist it in every way possible by advice, suggestion, and direction, to formulate a comprehensive fire plan for his district, take charge of large fires, keep in touch with the fire-lookout observers, and keep the whole organization up to an efficient standard. He further enlists the support of local organizations such as business men's clubs, churches, game and fish clubs, and boy scouts, brings action in the courts against offenders of the forest-fire laws, and utilizes every means at his command to prevent fires in his territory and to suppress promptly any fires that do start. The fire chiefs should be the most active compelling force in the fire organization.

The wardens and deputy wardens organize the fire-fighting crews, direct fire suppression, post fire warnings, carry on as much educational activity against fires as possible, issue fire permits, and, if the season demands it, patrol regions of extreme fire hazard.

All men in the organization have the authority to impress other men into service to fight fires.

3. A system for detecting and reporting forest fires as soon after their inception as possible. This makes it possible to take prompt suppression measures that will hold fires to a small area.

Prompt detection and prompt suppression of fires are the key to small losses in woods fires just as in city fires. The ordinary practice is to locate fire-lookout towers 15 or 20 miles apart on prominent hills, where the men on duty during the season when there is danger of fires can overlook the intervening territory. These towers are generally of steel construction, of various heights up to 60 or 70 feet, have an inclosed glassed-in top so that the observer can remain on the tower even on cold windy days, and are provided with a map mounted on a table and a sighting device (alidade) which enables the observers to locate fires quickly. Their cost in place ordinarily varies from \$1,000 to \$2,500. The towers have the ordinary telephone service of the region which enables the observers to report promptly any fires that are detected. If the local telephone service is unreliable, a special official telephone line is very commonly constructed from the observation tower to a reliable public line or to the home of a local fire warden.

4. A modification of the fire-lookout tower system is employed in some instances where the wooded territory is broken up by farms or settlements to such an extent that farmers or other residents are certain to see a forest fire about as quickly as an observer on a lookout tower. Under these circumstances, an effort is made to interest whole communities to serve as voluntary fire observers and to appoint some of their number to take charge of fires when reported. Such a plan ordinarily aims to provide one fire warden for each 2,000 or 3,000 acres of timberland. These men are unpaid except when actually fighting fires.

5. To supplement both these detection and suppression forces already mentioned, some States at times employ patrolmen, who actually patrol the country where fire danger is great. During the early fishing season when the woods are dry and inflammable they spend their time along streams or lakes most frequented by fishermen. They warn fishermen against throwing away lighted matches or burning tobacco, or leaving camp fires burning. Commonly, they come upon and extinguish small fires in the woods or camp fires left burning before these have been seen by the men on the lookout towers. During the summer they are busy with summer campers and tourists, and during the fall their attention is turned to the hunters.

Experience has indicated that the best results are obtained where all men are employed by a central State organization and all public activities in prevention, detection, and suppression of forest fires come under its direction. There should be no division of administrative authority between the State and lesser political subdivisions such as the town or county. The costs of fire suppression should first be met by the State, but a portion of it, ordinarily one-half, should be billed back against the county, town, or local political subdivision within whose limits the fire occurred. This brings the forest-fire problem home to the local population in an effective way and teaches them the need of exercising care to prevent forest fires, a vast majority of which are commonly due to carelessness and thoughtlessness, often of local people.

Any organization is impotent without adequate funds for its support. A poorly organized, poorly administered, and poorly paid

forest-fire organization is on a par with a similarly organized and equipped city fire department; it is rather a liability than an asset. It creates a feeling of security which is unjustified and which leads to a rude awakening when a real fire crisis arises. Forest fires when handled by such an organization usually burn themselves out.

The fire-control organization must not only be well-manned; it must also be well equipped. Good glass-inclosed fire-lookout towers are several times as effective as the cheaper uninclosed stations. Up-to-date forest-fire fighting equipment in quantity is essential to success. It should be distributed throughout the forest districts of the State, preferably with the district wardens, where it can be rushed to any fire on call. Equipment should include ample quantities of shovels, axes, brush hooks, rakes, hand and power water pumps, and other modern fire-fighting implements.

The forest-fire organization is responsible for enforcing the forest-fire laws of the State. These ordinarily prohibit:

1. Kindling fires in the open without permit from a forest-fire warden. Such permits are subject to revocation by the fire warden if he deems it advisable.
2. Throwing down lighted matches, cigars, cigarettes, or other burning substances when and where they may endanger woodlands.
3. Leaving a camp fire while it is burning.
4. Setting fires which will endanger the property of another.
5. Setting fires to clear land.
6. Carrying naked torches on forest lands.
7. Sending up unpiloted hot-air balloons.
8. Depositing fire, live coals, or hot ashes, unless they are properly protected, upon any railroad track or right of way on or near forest land.

The laws ordinarily require railroads to keep their rights of way through forest lands clear of inflammable material, to patrol their tracks through forest lands for fire at certain seasons of the year when ordered to do so by the State forestry officer, and to instruct their own employees to extinguish fires along the rights of way. Locomotives and other steam plants operating in or near forest land are required to be equipped with spark arresters and the locomotives with suitable ash pans to prevent the escape of fire.

Other requirements include the clearing away of slash resulting from cut timber in a strip 25 to 60 feet wide adjacent to public highways, steam or electric railroad rights of way, and timber property belonging to other owners. Railroads are permitted to enter upon forest or brush land adjacent to the right of way for the purpose of removing inflammable material for a specified distance. The clearing away of slash and other debris for a distance of 100 feet or so around portable mills set up for operation is ordinarily required, and the removal of cut brush within the limits of any public highway.

Private owners of large blocks of timberland are generally required to provide adequate patrol against forest fires.

Some State laws permit the governor, during periods of excessive fire danger, to close the woods to persons whose presence might create a fire hazard and to close or change the dates of the open season for hunting, trapping, and fishing.

Cooperation between the State and the Federal Government in forest-fire prevention and suppression is generally authorized.

PRIVATE RESPONSIBILITY

The active interest of the State in the prevention and suppression of forest fires where such fires constitute a real problem should not relieve the timber operator of the responsibility of protecting his own property, the adjoining property owner, and the public in general against the special hazards which his operations create and leave behind. This has reference in particular to the slash or tops, culled logs, bark, and chips left in the woods following timber operations. These create in places a state of inflammability, in effect a nuisance, which the public has a right to expect the operator to care for. When weather conditions are favorable to its spread, fire in cut-over land covered thickly with the dead tops of trees is almost impossible to combat successfully. At such times the slash burns with so great a heat that conflagrations are started far in advance of the head of the fire, and men can not combat it as successfully as they can the ordinary leaf and grass fire that creeps through the woods. They can not approach the head of the fire closely and are usually obliged to let it burn through the slashing or to back fire. Either course means much land burned over and often the destruction of many young trees a few inches to a few feet high.

In any logging operation where the timber is cut heavily and not utilized to a size of 4 or 5 inches in the tops, a great deal of slash ordinarily results. From the standpoint of reducing to the minimum the extent and severity of forest fires, it is desirable to dispose of this. The danger of severe fires in cut-over lands can be most nearly obviated if the slash is lopped down to sticks 2 or 3 inches in diameter, piled, and burned when it is safe to burn. The piles should be 4 or 5 feet high and 6 to 8 feet across, kept well apart and 10 or 15 feet distant from living trees. With wages at \$2 a day, it costs 50 or 75 cents per thousand board feet of timber cut to take care of pine slash in this manner and 65 cents to \$1.40 to take care of hardwood slash. The lower costs are possible if the slash is piled and burned as logging progresses; the higher costs are entailed where the tree tops are permitted to become dry and hard before being lopped and piled.

Hardwood slashings will as a rule be nearly as safe if the branches down to those 2 or 3 inches in diameter are lopped from the tops and scattered over the ground. This will save at least the cost of burning, 15 or 20 cents a thousand. The fire danger is not everywhere so acute as to make slash disposal necessary over the entire areas logged, but it does seem essential on particular areas where both the inflammability hazard and risk are high to dispose of the slash by the methods discussed or else to provide special intensive patrol there. Pine slashings are more inflammable than hardwood slashings and do not rot so quickly. Hardwood slash left from a summer cutting is more dangerous than slash left in winter, because the former holds the dried leaves on the twigs. Cut-over south slopes become drier than north slopes and consequently are more likely to burn.

The risk is great where travel is heavy, as along main highways and much-used back roads and trails. It is great along railroad

rights of way, along streams and around ponds frequented by fishermen, where men are working in the woods, and near cities where people frequent the woods on holidays and Sundays.

The methods for timber operators to employ in taking care of especially hazardous areas can be left to them, provided the methods chosen are effective and conform to State laws. Posting fire warnings and educating woods workers and other people of their own community may go far to lessen the danger from fires. Clearing the ridge roads of leaves and other inflammable material in the spring and fall before the fire season gets under way would be a helpful measure where the risk is great. This would probably cost \$5 or \$6 a mile. Piling and burning the slash within 100 feet of a sawmill setting and in a strip 100 feet wide along the much-traveled roads and railroad rights of way would be a good measure.

If the slash on particularly hazardous areas is not disposed of by piling and burning, intensive patrol during the fire season for a period of three to five years following logging operations is necessary. This would mean a cost of 3 or 4 cents an acre a year, figuring one man to each 10,000 acres. Several timberland owners might well form an association to carry on patrol work jointly at less expense to each. Perhaps some system of bonuses under which payments could be made on a graduated scale based inversely on the number of forest fires and acreage burned in the local school districts or political subdivisions would prove a most effective means of fire prevention and suppression. A plan of that nature was put into effect in Ripley County, Mo., on 6,000 acres of forest land owned by the University of Missouri. A bonus of \$1 a year was paid to the local school district for each 40-acre subdivision on which no fires occurred and from which no timber was stolen. During a five-year period no fires occurred on the tract.

On particularly hazardous areas the timber operator should be able within one to three hours after the discovery of a fire, and sooner if possible, to put on a crew of 10 to 15 men well equipped with fire-fighting tools. If given even an hour's start, some fires reach almost uncontrollable size and intensity.

EDUCATION OF THE PUBLIC

Along with any State and private system which provides for the detection and suppression of fires there must go a persistent educational campaign designed to interest the whole community or region in the subject of fire protection and to convince the people that it is to their own interest to prevent forest fires. The forest-fire problem will not be solved in any region until fire prevention becomes a community interest. The intensity of the organization necessary will not be governed mainly by any particular type of forest but rather by the sentiment in any district in favor of, indifferent to, or opposed to fires.

MEASURES NECESSARY TO PRODUCE FULL TIMBER CROPS

Where there is already in this region a reasonable degree of control over forest fires and over heavy pasturing of the woods and where



EFFECTIVE MEANS FOR PROTECTING FORESTS FROM FIRE

Where forests are extensive, lookout towers are imperative (A). Water is also an invaluable aid. Small, handy pumps (B) have many times saved the day. Where roads are passable, a truck operating a pump and carrying 1,000 feet of hose (C) is very effective



IT PAYS TO FAVOR TREES LIKE YELLOW POPLAR, ASH, AND WALNUT

This yellow poplar on the Ohio uplands (A) has been developed by skillful management on the owner's part, and will bring a valuable return on the investment. An equally profitable stand (B) is one in which white ash is the predominating species

economic conditions make it feasible, further steps can well be taken toward obtaining full timber crops in the sense of maximum volume production of timber; and some discrimination can also be exercised as to the kind and quality of timber to be produced.

PRIVATE MEASURES

METHOD OF CUTTING THE TIMBER

GENERAL PRINCIPLES

There have been no thorough investigations in this region to determine the best methods to follow in cutting timber—best in the sense of producing and harvesting timber continuously as a crop. There is accordingly no claim of finality for the methods suggested here. These methods are based upon opinions of men familiar with the region and upon observations of woods which have been cut; in time they will doubtless need considerable modification. It seems abundantly evident, however, that in most instances a system of cutting which removes only a relatively small number of the trees in any one logging operation offers the best assurance of a continuous growth of timber trees on the area, the least deterioration of the soil factors that influence growth, the least damage from forest fires, the possibility of coming back to the same area at relatively frequent intervals for more timber, and the possibility of gradually increasing in the stand the proportion of more valuable species.

Mixed stands of hardwoods lend themselves naturally to this type of cutting. Some species such as cottonwood, yellow poplar, and red gum grow faster than others and reach marketable sizes sooner. Others are in demand in smaller sizes, such as ash and hickory for handles, locust, red cedar, and mulberry for posts, and the oaks for mine props. The current market values of timber may make it advantageous to defer cutting of certain species even when they have reached merchantable size. The problem is so complex that only general principles can be stated; specific rules to cover every condition found in the woods can not be formulated.

In principle, the larger mature trees should be removed as they reach merchantable size. The young trees which are healthy and well-formed should be left to grow larger and proportionately more valuable and to be cut later. The less valuable trees should be cut the most heavily and down to small sizes, in order to eliminate them gradually and give place to better trees. Judgment must be used in leaving trees, however. It is not good practice in logging a heavy stand to cut out all the large trees and leave scattered over each acre as few as 25 or 30 tall, slim, small-topped poles. These will invariably be broken off or thrown over by storms. Either they should be cut or, if left uncut, enough of the larger trees should be left with them to give solidity to the stand and prevent wind throw. If, however, these tall slim poles occur in bunches or patches of one-fourth acre or more, they will not be in great danger of being uprooted.

Often patches of vigorous, slender poles entirely surround one or more larger trees that ordinarily would be taken in logging. If the tops of the larger trees are well above those of the poles and will not

interfere with the growth of the latter, the large trees should be left standing. To fell and skid them out would mean an unwarranted amount of damage to the poles. If the larger trees are branched low down, they should be cut out with the least possible damage to the poles. If allowed to remain they will do approximately as much damage in obstructing the development of the poles as may result from their removal.

The retaining of the younger trees is advisable not only in order to have proportionately more timber to cut in later years, but also because there is ordinarily not much profit either to the owner in selling them or to the operator who logs and saws them into lumber. Small timber sold by the thousand feet and measured by the log scale in common use in the region will scale only 50 to 75 per cent of the quantity of lumber actually sawed out at the mill. The owner is accordingly the loser. Furthermore, the small trees are so expensive to log and mill that timber buyers can not afford to pay much for them. Some investigations have indicated that timber operators logging to a sawmill sometimes make little or nothing on small logs and would at least be just as well off if they did not cut the small trees. It seems to be far better policy, accordingly, for the timber owner to hold young growth for larger sizes, better quality, and correspondingly higher stumpage prices, although there may of course be circumstances under which this policy would not hold true.

Investigations made by Ashe⁵ led him to the conclusion that:

The cost of operating hardwood trees below 16 inches in diameter is out of all proportion to the value of the lumber which they yield.

The cost per thousand feet of felling, bucking, and mill-sawing trees between 14 and 15 inches in diameter is more than double that for trees of 20 inches or more in diameter.

The cost of skidding is more than treble.

For trees smaller than 12 inches, the relative cost per thousand feet is even higher, being about five times as high as for trees 20 inches and over in diameter.

In most operations in virgin stands, where clean cuttings are practiced, the larger timber is paying in large part for the cost of operating the smaller.

Much of the small timber is cut at a loss, notwithstanding that it contributes proportionately to reducing the charges per thousand due to mill construction, transportation construction, and overhead.

In considering small trees, however, the distinction needs to be made between young small trees and old small trees. Some small trees may be just as old as their very large neighbors, having been dwarfed through some cause or other, usually because of too much crowding. They will probably never amount to anything even after the competing trees are cut from around them but will simply take up room that the future crop of younger trees should occupy. The woods owner should cut out such trees during logging operations, even at a financial sacrifice.

Another principle which seems to hold in general is that it is not good practice for the owner of timber to sell from his woods single specimens of certain much-sought and especially valuable species such as ash, hickory, basswood, yellow poplar, red gum, white oak, and black walnut. These are the most valuable trees in the woods.

⁵ ASHE, W. W. THE FORESTS OF THE FUTURE—SECOND GROWTH. Southern Lumberman, Aug. 5, 1916.

They are the ones whose proportion in the stand the owner should constantly strive to increase. If they are sold separately and in advance of the others, these species not only will decrease in the stand but they will gradually be eliminated from it. Other less valuable species such as maple, elm, hackberry, black oaks, beech, ironwood, and black gum will take possession of the open spaces. The low value to-day of much of the woods in this region is due in part to the fact that this practice has been followed for years.

Still another general principle which should be observed is to take advantage of logging operations in any type or situation to clean up the woods. In other words, this should be the opportunity for getting rid of hollow trees; trees affected with rot or other diseases, killed or dying from insect attack, or badly fire-scarred at the base and almost certain to develop rot or to become wormy; trees whose tops have been broken by storms, lightning, or previous logging operations and which will not in consequence develop into valuable specimens; and trees with large spreading crowns which have little or no value at present and never will have much value. It may be necessary to dispose of these trees for little or nothing or even at a financial sacrifice to get rid of them, but it will be well worth while to do so. The ax judiciously applied is a tool for building up the forest as well as for cutting it down.

Without doubt the general rule of cutting rather evenly and only about one-half the volume of trees over the whole area logged will have to be modified to assure reproduction of certain species. Ash, yellow poplar, and red gum seedlings, for instance, come up proportionately most thickly on areas which have been cut clean of old growth or at least cut very heavily. This suggests the advisability of clean or heavy cuttings in patches of an acre or so where old trees of any of the three species mentioned occur in the stand in some quantity and where the site is favorable for the growth of high-quality timber. Conditions are most favorable on good, moist, well-drained soils, such as lower slopes, coves, well-drained bottom lands, north slopes, and rich bench lands and flats.

It is recognized, moreover, that in some stands of timber where the trees are all old, no longer growing thriftily, and in many instances defective, the only sensible method to follow in logging operations is cut clean and thus put the area in shape for a new growth of young vigorous healthy timber. This is the best practice on such areas from the standpoint both of the operator and the landowner who wishes to grow another crop of timber on the land.

In the mixed stands of the central hardwood region it can not be stated with assurance that any method of cutting will be entirely effective in controlling the future composition of the forest. This is particularly true of species which require an abundance of sunlight, such as yellow poplar, black walnut, red gum, and cottonwood. Under old stands of timber there are commonly large numbers of seedlings such as maples, ash, and elm which endure considerable shade. These are ready to take possession of any openings created by the removal of old timber. Some of the light-requiring seedlings will come in, but they are often obstructed if not crowded out altogether by the shade-enduring trees which were there first. It will be necessary to thin out the latter to give others their chance. It

appears, in fact, that such thinning or culling out of the poor species when the stand of trees is young will be far more effective in controlling the composition of the new stand than any system of cutting in the old stand that might be followed. Whether or not these operations are feasible at the present time is something for each owner to determine. In the long run, they will pay. It is a proposition of building up the assets of the timber property.

IN VIRGIN OR LIGHTLY CULLED STANDS

Upland type.—In the upland type of the northern part of this region, white oak, black oak, scarlet oak, northern red oak, black walnut, butternut, white elm, white ash, beech, basswood, hickory, yellow poplar, and hard maple are the predominating species. Of these, the yellow poplar, basswood, and red oak grow the most rapidly and are excellent species to favor in the stand if possible. Because of its high market value, black walnut is another. White ash and hickory are not so rapid in growth but are very valuable commercially in smaller sizes than the others; they should also be favored. Although a very fine species, the white oak does not grow rapidly and is not particularly valuable in small sizes; it does not appear to be so good a tree to favor here as the others mentioned, except for some special purpose which the owner has in mind or in situations where it is decidedly the predominating and best species present, as in some stands of mixed oaks. The hard or sugar maple is slow growing and not highly valuable for its lumber. It is a very fine tree to have in a mixture with others, however, because it produces quantities of leaves that are returned to and enrich the forest soil; moreover, it can be developed into sugar orchards. Ordinarily, if present in a stand, it will maintain itself in sufficient numbers without any special help.

Occasionally other species occur which have a special value, such as red mulberry for fence posts. These should be favored. Other species in the stand should be cut more heavily and gradually eliminated from the woods. This is particularly true of ironwood and blue beech, both of which bear seed when as small as 2 or 3 inches in diameter and crowd into openings of the forest.

In the upland type of the southern part of this region northern red oak, basswood, scarlet oak, and butternut are not so abundant. Blackjack oak, post oak, southern red oak, chestnut oak, chestnut, black locust, black gum, buckeye, persimmon, and dogwood come into the stands. Here the species to favor are yellow poplar, the red oaks, black walnut, ash, hickory in moist situations, black locust, and to a less extent hard maple. White oak, chestnut oak, southern red oak, and perhaps black oak growing on poor soils should be favored over post oak, blackjack oak, black gum, and hickory, which ordinarily occur in mixture with oaks on these soils. Chestnut should be eliminated from the stands because it seems certain to be killed by the chestnut blight. Ironwood, blue beech, black gum, dogwood, hawthorn, redbud, sassafras, persimmon, buckeye, and similar species of little or no value should be cut just as closely as possible.

In the upland type it is believed that, except to meet specially favorable market opportunities, the hardwood trees of the most valuable species should not be cut before they are 18 or 20 inches in

diameter. Trees smaller than that saw out a high percentage of low-grade lumber; in consequence their stumpage value is low. Probably not over 50 per cent by volume of these better species should be cut in any one logging operation. This will ordinarily mean that more than 50 per cent of the large timber will be taken, but a plentiful reserve of smaller timber will be left to develop into the next crop. If by any chance it involves also the elimination of the better species over a considerable area, one or more trees of the better kinds over 18 inches in diameter should be left on each acre to serve as seed trees. Several seed trees to the acre would be best, but perhaps could not be justified economically. Second-growth ash and hickory, which are valuable in the smaller sizes, may sometimes be cut down to 14 or 16 inches in diameter. The poorer species, which are to be discriminated against, should be cut just as small as possible.

Mixed hardwood and conifer subtype.—In the stands of this type, the species to favor are yellow poplar, white ash, red oak, black walnut, white oak, chestnut oak, shortleaf pine, red cedar, and perhaps the black oak. The species to be discriminated against when they are mixed with the foregoing are blackjack oak, black gum, hickory, chestnut, ironwood, dogwood, redbud, sassafras, and persimmon. Hickory in this type is commonly brash and of poor quality.

Because of the relatively slow growth, low yields, and comparatively low economic value of most of the hardwoods which occur on ridges and south slopes in mixture with shortleaf pine, it is desirable to increase the proportion of pine to the extent even of working over into a pure pine type. This appears possible if the pine is not cut to a smaller diameter than 12 or 14 inches, and in no case more heavily than 50 or 60 per cent of its volume on an acre.

The hardwoods standing in mixture with the pine are often scrubby and of no commercial value, particularly the old trees. The hardwoods of merchantable quality should be cut out to the smallest commercial sizes, the smaller trees being utilized, if possible, for ties, cord wood, and mine timbers. Although it may not be practicable in many instances, it is advisable, if possible, to fall the worthless specimens of hardwoods and allow them to lie on the ground. If allowed to stand, they take up space which growing pine should be occupying.

On north slopes or on other sites where the hardwoods run strongly to white oak and other species of good quality and thrifty growth in mixture with pine, it would commonly be difficult except at unjustifiably heavy expense to increase the proportion of pine. Here the valuable hardwoods should in general be cut to a diameter of 18 to 20 inches; the inferior hardwood species and all worthless or diseased trees should be cut to the smallest sizes feasible; and the pine to a diameter of 12 to 14 inches.

The stands of nearly pure pine should be handled the same as mixed hardwoods and pine on ridges and south slopes. Barring fires coupled with exceedingly heavy cutting operations, such stands should maintain their predominant pine character.

Stands in which red cedar occurs in quantity, as in parts of the Missouri Ozarks, should perhaps be treated so as to favor this species. It is a very valuable fence-post tree, and commands a ready market for that purpose. The trees ordinarily occur in a wide variety of

sizes, from mere seedlings to those large enough for fence posts. To keep the area producing cedar it seems necessary merely to follow the plan of cutting only trees of fence-post size or larger, avoiding damage to the younger cedar that is coming on, leaving here and there a few scattered trees large enough to bear seed, and cutting out other trees that interfere with the growth of the cedar.

Bottom-land type.—Of the trees which make up the stands in this type the best are yellow poplar, ash, red gum, white oaks, southern red oak, shagbark and shellbark hickories, cottonwood, and river birch. The less desirable are the soft maples, elm, hackberry, pin oak, water oak, sycamore, pecan, bitternut hickory, honey locust, and the southern cypress. In this type the merchantable trees are larger on the average and number more to the acre than on the uplands.

The virgin or only slightly culled stands lend themselves to a system of partial cutting, provided the better species are not taken below a size of 24 to 30 inches in diameter. The poorer species should be cut to their smallest merchantable sizes. This will ordinarily leave a nucleus of 50 per cent or more of the total number of trees for subsequent cutting and will not wreck the stand.

If the cut is closer than this, only a scattered and very likely broken or badly damaged growth of tall, slender poles and some worthless, spreading-topped, and scrubby trees will remain. The poles when exposed to the full force of the winds will be toppled over; the other trees will not increase much in size or value and will simply take up valuable room. Rather than bring about this situation it is better to cut these bottom lands clean of all timber except occasional solid patches of young, vigorous growth too small for the most profitable utilization. These bottom lands will come back quickly to young trees, which will grow rapidly and produce a second crop much sooner than will the young growth in the uplands.

Mention has been made of pure stands of cottonwood on the bottoms. These are not extensive, but occur on islands and on land newly formed by streams in flood stage. Cottonwood seed is deposited in the soft mud as the flood recedes, and under these favorable conditions sprouts and grows rapidly. There is no competing growth, unless it is willow. Only as the soil becomes fixed do other species of trees begin to come up under the cottonwood. The most common of these are soft maple, elm, ash, hackberry, pin oak, and river birch. Once these species get possession of the site cottonwood seedlings and saplings are very rare.

When the cottonwood reaches saw-log size, there appears to be no known method of cutting which in itself will maintain this tree as the dominant species in the stand. Clean cutting of the cottonwood and the destruction of all undergrowth of other trees or perhaps plowing the land and planting to cottonwood would be a very expensive undertaking. If cottonwood, however, is cut for pulp wood when 10 or 12 years old, it will probably maintain itself by sprout growth for a couple of crops. Then it will be necessary to cut out all the other trees present if the third crop is not to be shaded out.

IN SEVERELY CULLED STANDS

In upland or bottom-land stands that have been severely culled of their best timber, and perhaps also burned or heavily grazed, the necessary measures are such as will lead toward rejuvenation of the stand. The only cutting that needs to be done at the beginning is to take out any trees of undesirable species that are large enough to bear seed, such as ironwood, blue beech, black gum, blackjack oak, persimmon, sassafras, and other definitely inferior kinds. This is necessary in order to prevent the land from being seeded in heavily with these inferior species to the exclusion of the better ones. Timber is extremely persistent, and if given freedom from fires and from heavy grazing the more desirable species will begin to come back on these lands, usually within three to seven years. The fact needs to be recognized, however, that it may seldom be possible to bring old stands back quickly into a state where the best species form a high proportion of the young growth. The owner may be obliged to be satisfied at first with rather inferior timber, which he can by subsequent care develop gradually into a more valuable property.

Where there are a thousand or more seedlings or saplings to the acre fairly well distributed, any old big-topped, defective, or otherwise worthless trees should be cut out or girdled, in addition to those mentioned in the preceding paragraph. This is simply to free the area of trees which have little or no potential value and which would interfere with the growth of the young trees.

In some of the worst of these severely culled and badly run-down pieces of timberland, it may even be necessary to plant trees in order to get a fair growth of young timber within a reasonable length of time. Infertile ridge tops, areas where blackjack oak, scarlet oak, post oak, black gum, or a poorer grade of hickory predominate, and old abandoned fields coming in to sassafras, persimmon, cherry, elm, ironwood, or similar species, are typical examples. Conifers ordinarily are more successful than hardwoods when planted on soils of low fertility. Since forest planting ordinarily costs \$10 to \$20 an acre, the choice of species should be determined only upon the advice of the State forester.

IN EVEN-AGED STANDS OF SECOND GROWTH

The even-aged stands of second growth in this section are mainly confined to mixed stands of oak and hickory on the hilly lands of the Ozarks, southern Ohio, Indiana, and Illinois, and the highland rim of Kentucky and Tennessee. These stands, both by composition and character of growth, lend themselves well to the production of railroad ties, mine props, and in some cases cordwood. Because of the large supply available the market for cordwood as a rule is poor; that for ties and mine props varies with the sizes wanted and the prices offered, but is fairly steady. If the stands are very badly fire-scarred, it may pay to cut them clean for such products as they will afford and strive for improvement in the new crop that will spring up. Otherwise they should be cut by selecting out here and there the tie-sized trees or those suitable for mine props.

It seems undesirable to cut trees for ties until they are large enough to yield not less than 2 or 3 ties. Commonly trees 10 or 11 inches in diameter are cut for 1 tie, whereas with 15 or 20 more years of growth they would cut 2 or 3 ties. If the timber is cut for mine props, however, the sizes that are in demand will regulate the cutting, varying with the thickness of the coal seams mined. The tops of trees felled for ties are often suitable for mine props.

The black oak and red oaks are the most rapid-growing trees in these stands; white oak is more rapid than post oak or blackjack oak. The last is commonly very shaky and except occasionally is fit for nothing but cordwood. Black oak, red oaks, and white oak should be favored as much as possible in these stands; post oak and blackjack oak should be cut more heavily and to smaller sizes. Individual trees which will never develop into merchantable specimens should be cut out entirely, as should ironwood, redbud, black gum, persimmon, dogwood, and other such worthless species. Because of the ready market for ties and mine props, these stands lend themselves ideally to a system of continual cropping at intervals of a few years. The smaller sizes can be utilized for mine props and the larger sizes for ties. On lower slopes and along stream courses where the growth is most rapid, occasional stands may be permitted to develop to saw-log size.

SLASH DISPOSAL

No alteration of the methods already discussed for the disposal of slash after logging is proposed. Such disposal may sometimes be justified, however, by at least one other reason than protection against forest fires. Any great amount of slash left lying will take up space that should be growing trees and will often smother out small trees which are just starting or cause them to grow crooked for a few years.

OPERATIONS FOLLOWING CUTTING AND REGROWTH

Following the establishment of young growth (commonly called brush) through seedlings or sprouts, the owner has the opportunity to control to a large degree the species which will predominate in the mature stand. Of the seedlings or sprouts that begin life on each acre of forest land, the valuable species may represent only one-tenth or less out of a total of several thousand, of which, when the timber reaches maturity, only 50 to 300 trees may be of merchantable size. Obviously, it is to the owner's advantage to have all or nearly all of these merchantable trees of the better and more valuable species. He can effect this by cultivating the stand with an ax when it is in the seedling, brush, sapling, and small-pole stages. This means going through the woods with an ax and cutting out the poorer species. Even when the better species are decidedly in the minority as small trees, this operation can make them an important part if not the dominating species of the mature stand. The operation may have to be repeated several times at intervals of 5 or 10 years; good judgment will indicate when this is necessary.

In those stands, particularly of farm woods, which have been rejuvenated simply by eliminating grazing and preventing fires, the

old trees which were left standing to scatter their seed over the area have fulfilled their function as soon as a good stand of young trees is established. If old, defective, large-topped, or crooked and of poor timber value present or prospective, they should be cut out. They will serve no further useful purpose and are taking up space that should be occupied by young, vigorous trees.

These operations may mean more expense to the owner than the material cut out will be worth; in fact, the timber may have no commercial value whatever. The chief return from the operations will be the assurance of increased value of the mature stand owing to the higher proportion of better species composing it. On farms, these operations can often be carried on during the winter when other work is slack at no actual outlay of cash; moreover, they should be the means of supplying the year's fuel wood.

PROTECTION

The protective measures to be taken against fire have been adequately outlined in a previous section. Those necessary to keep forest land productive will be ample to insure full timber crops. Protection against overgrazing has also been outlined sufficiently. There would be more assurance of beech and oak production, particularly of white oak, if hogs could be prevented from roaming at will. Their appetite for acorns and beechnuts is otherwise liable to eliminate or greatly reduce these species.

Protection against forest insects and diseases is most urgent. The forest owner is almost helpless when it comes to combating the sweeping attacks of these enemies by any of the direct methods commonly applied to shade and roadside trees. Where attacks are occurring or are imminent, the woods owner can only discriminate against the species subject to attack by removing them in cutting and thinning operations. White pine can be protected against blister rust by pulling up all wild and cultivated currant and gooseberry bushes within or near the tract of white-pine timber.

In parts of this region the ashes have been heavily infected with oyster-shell scale; hickory in northeastern Ohio is being killed by the hickory-bark beetle; the black locust has suffered severely from both the locust borer and the locust-leaf beetle. Doubtless other species of trees have been severally attacked by insects and by diseases. No definite recommendations for control of all insects or diseases which attack trees in this region can be attempted here. In case of trouble with insects or diseases the advice of the State or Federal forest entomologist should be sought in the first instance and of the forest pathologist in the second.

PUBLIC MEASURES

PROTECTION

Public protection measures, like private measures, differ in no way from the minimum measures to keep timberland productive save in the warfare on insects and diseases. Public assistance in the control

of forest-tree insects and disease should take the form of scientific studies of forest insects and tree diseases by qualified experts in public employ, together with some assistance in applying such methods of control as prove practicable. The private timber owner should also be protected by quarantines against the importation of plant material carrying insects or diseases likely to spread and damage native timber.

PRODUCTION AND DISTRIBUTION OF SMALL TREES FOR FOREST PLANTING

States which grow small forest trees in State-owned nurseries and sell these at cost for forest planting are aiding the private owner materially in his efforts to obtain full timber crops. The State can usually grow these in large numbers, and so produce and sell them cheaply. In the central hardwood region, in 1926, Wisconsin, Michigan, Ohio, Indiana, Kentucky, Missouri, Nebraska, Kansas, and Iowa were engaged in this activity in cooperation with the Federal Government.

TIMBERLAND TAXATION

Timberland taxation is not immediately burdensome in all parts of the central hardwood region, but is indirectly so because of uncertainty as to the consistent application of present laws. To be really effective any system of timberland taxation should be on a State-wide basis and applied to all timberland. It should not be optional with a timberland owner whether or not he wishes his property to come under the terms of the law. That very largely would defeat the purpose of the law. Further, the plan of taxation must be basically sound and yet easily understandable and capable of application by local assessors. Also its immediate effect must not be to decrease materially the amounts of local annual revenue raised through taxation and it must not shift to other property a greater proportion of the tax levy. No solution of the problem satisfactory to all has yet been worked out. At present extensive forest-taxation studies are being undertaken by the Forest Service under the authorization of the Clarke-McNary law. These may develop some simple, workable, and fair methods of timber taxation.

PUBLIC OWNERSHIP OF TIMBERLANDS

Public holding of timberland is now commonly accepted as one of the best means of producing timber of high grade, which usually means timber of old age. Such holdings serve the purpose also of experimental and demonstration areas where the best methods of handling timber as a crop can be worked out for each region. National, State, county, and municipal forests promise to be of increasing importance. These often are developed from cut-over timberland that reverts to the State or counties for taxes, but very commonly the lands are purchased with public money for the deliberate purpose of setting them aside as public forests. The areas of State forests in this region and the total area of forest land are about as shown in Table 2.

TABLE 2.—*Areas of State forests*

State ¹	Total area of forest land in State	Area of forest land in State forests		State ¹	Total area of forest land in State	Area of forest land in State forests	
	<i>Acres</i>	<i>Acres</i>	<i>Per cent</i>		<i>Acres</i>	<i>Acres</i>	<i>Per cent</i>
Arkansas.....	3,300,000	-----	0.0	Minnesota.....	20,900,000	350,000	1.68
Illinois.....	500,000	-----	.0	Missouri.....	13,000,000	-----	.0
Indiana.....	1,000,000	3,547	.35	Ohio.....	1,100,000	33,773	3.06
Kentucky.....	9,000,000	3,624	.04	Tennessee.....	10,000,000	-----	.0
Michigan.....	18,400,000	333,000	1.83	Wisconsin.....	16,565,000	97,000	.59

¹ Forested areas and State forest areas for Michigan, Wisconsin, and Minnesota are given in full. However, about 80 per cent of the forest land in Minnesota and Michigan, and 70 per cent of that in Wisconsin, is of a totally different type from that of the central hardwoods and lies outside the region here discussed (see fig. 1). The State forest areas are somewhat similarly distributed, the greater portion lying in what is known as the Lake States region.

FOREST INVESTIGATIONS

There is much to be learned about the timber of this region, its rates of growth, the growing conditions under which it thrives best, the methods which should be followed in its management, the diseases and insects which attack it and how to combat them, and a great many related subjects. This suggests the need for a well-manned and equipped forest research station which would cover this field for the entire region and could cooperate with the State forestry officers and others in obtaining data on the stands of timber in each State, the disposal and utilization of timber products, and other subjects of general economic interest.

STATE FORESTERS

A State forester or similar officer is essential in every State to handle the State-owned timberlands, administer the forest-protection activities, produce and sell small forest trees, assist the private owner in his problems of producing and marketing timber, and meet the great demands for forestry information from people within the State. With the exception of Arkansas, each of the States in this region now employs a State forester.

RESPONSIBILITY OF THE TIMBERLAND OWNER AND THE PUBLIC

The timberland owner who wishes merely to keep his land in a reasonably productive condition, as has been shown, need observe but two general measures. He must discontinue pasturing the woods to the extent now the custom on 75 per cent of the small farm woods of the region; and he must prevent the forest fires now common in the hilly sections of southern Ohio, Indiana, Illinois, the highland rim of Kentucky and Tennessee, and the Ozarks of Missouri and Arkansas. With these two measures in force there will be no question about timberland being productive. With fires and heavy pasturing eliminated it is believed that the timberland of the central hardwood region will produce at least 50 per cent more timber than when subjected to these influences. This increase would be

realized both in a greater number of standing trees and in less defect in the timber grown.

If the timberland owner attempts to produce full timber crops he must, in addition, somewhat modify his methods of cutting. It may be well to summarize briefly in this connection the silvicultural measures proposed:

1. The general principle should be to cut not over 50 or 60 per cent by volume of the timber at one time. The largest trees of the better species should be cut out and the thrifty smaller trees left to grow in size and value and to be cut later. The inferior species or the poorer specimens in all sizes and types should be cut out as far as possible so as to eliminate them from the stands. The practice of cutting in advance of the other timber certain selected and valuable species in the stand, such as ash, hickory, black walnut, and yellow poplar, should be stopped. To maintain or increase the proportion of ash, red gum, and yellow poplar in the stands, it appears necessary to clear-cut over small areas, or at least to cut the timber more heavily than 50 or 60 per cent by volume.

2. In virgin or only lightly culled stands of the upland hardwood type, the valuable species should be cut to a diameter of 18 or 20 inches, and the less valuable species to the lowest merchantable diameter.

3. In mixed stands of pine and hardwoods, as well as in stands of nearly pure pine, the pine should not be cut to a smaller diameter than 12 or 14 inches. On south slopes and ridges all hardwoods should be cut. On north slopes thrifty hardwoods under 18 or 20 inches may be left.

4. In mixed stands of red cedar and hardwoods the cedar should be cut to fence-post sizes, leaving scattered larger trees to bear seed. All hardwoods interfering with the growth of the cedar should be cut.

5. In the bottom-land type the diameter limit for the valuable species is 24 to 30 inches. If this high diameter limit can not be maintained, the stand should be cut clean of all stems except even-aged groups or patches of young, rapidly growing, and valuable species.

6. Badly culled, burned, and grazed stands must first be rejuvenated by excluding grazing animals, by preventing fires, and in some cases by forest planting. When a young growth is established, the decadent and broken trees can be removed.

It is not possible to estimate closely the extent to which the observance of these measures will improve the quality of a forest or wood lot, but it is certain that the owner will approach closely the maximum return from his land and the best price for his products. He can not expect immediate effects either from protection against fire and grazing or from cutting only a part of the timber in logging operations. There will be no overnight change in the character of the timber or in its growth. A period of years must elapse before results will become evident. It is reasonably certain, however, that his property will gradually develop to the point of yielding each year the equivalent of 100 board feet an acre on the poorest soils and 500 or 600 board feet on the best. That means that at the end of each 10-year period 1,000 board feet, or its equivalent

in ties, props, or cordwood, could be cut from an acre of the poorest lands and 5,000 or 6,000 board feet from the best lands.

The public should assist the private timberland owner in the production of full timber crops by working out control methods for insects and diseases and protecting the timberland owner against them by quarantines, by assisting in the forest-fire problem, by the production in public nurseries of small forest trees for distribution to private planters, by forest investigations which will be of general benefit to timber growers, and by employing State forest officers to assist private timberland owners in their problems.

LIST OF MORE IMPORTANT TIMBER TREES OF THE CENTRAL HARDWOOD REGION

Common name	Scientific name
Blue ash	<i>Fraxinus quadrangulata</i> .
Green ash	<i>Fraxinus pennsylvanica lanceolata</i> .
Red ash	<i>Fraxinus pennsylvanica</i> .
White ash	<i>Fraxinus americana</i> .
Basswood	<i>Tilia glabra</i> .
Beech	<i>Fagus grandifolia</i> .
Paper birch	<i>Betula papyrifera</i> .
River birch	<i>Betula nigra</i> .
Black gum	<i>Nyssa sylvatica</i> .
Black locust	<i>Robinia pseudoacacia</i> .
Butternut	<i>Juglans cinerea</i> .
Hardy catalpa	<i>Catalpa speciosa</i> .
Black cherry	<i>Prunus serotina</i> .
Chestnut	<i>Castanea dentata</i> .
Eastern cottonwood	<i>Populus deltoides</i> .
Swamp cottonwood	<i>Populus heterophylla</i> .
Southern cypress	<i>Taxodium distichum</i> .
American elm	<i>Ulmus americana</i> .
Slippery elm	<i>Ulmus fulva</i> .
Hackberry	<i>Celtis occidentalis</i> .
Bitternut hickory	<i>Hicoria cordiformis</i> .
Mockernut hickory	<i>Hicoria alba</i> .
Pecan hickory	<i>Hicoria pecan</i> .
Pignut hickory	<i>Hicoria glabra</i> .
Shagbark hickory	<i>Hicoria ovata</i> .
Big leaf shagbark hickory	<i>Hicoria laciniosa</i> .
Honey locust	<i>Gleditsia triacanthos</i> .
Black maple	<i>Acer nigrum</i> .
Red maple	<i>Acer rubrum</i> .
Silver maple	<i>Acer saccharinum</i> .
Sugar maple	<i>Acer saccharum</i> .
Red mulberry	<i>Morus rubrum</i> .
Black oak	<i>Quercus velutina</i> .
Blackjack oak	<i>Quercus marilandica</i> .
Bur oak	<i>Quercus macrocarpa</i> .
Chestnut oak	<i>Quercus montana</i> .
Chinquapin oak	<i>Quercus muhlenbergii</i> .
Laurel oak	<i>Quercus laurifolia</i> .
Overcup oak	<i>Quercus lyrata</i> .
Pin oak	<i>Quercus palustris</i> .
Post oak	<i>Quercus stellata</i> .
Red oak	<i>Quercus borealis</i> .
Southern red oak	<i>Quercus rubra</i> .
Scarlet oak	<i>Quercus coccinea</i> .
Swamp chestnut oak	<i>Quercus prinus</i> .
Swamp white oak	<i>Quercus bicolor</i> .
Water oak	<i>Quercus nigra</i> .
White oak	<i>Quercus alba</i> .
Willow oak	<i>Quercus phellos</i> .
Persimmon	<i>Diospyros virginiana</i> .
Shortleaf pine	<i>Pinus echinata</i> .
Virginia pine	<i>Pinus virginiana</i> .
Eastern red cedar	<i>Juniperus virginiana</i> .
Red gum	<i>Liquidambar styraciflua</i> .
Sycamore	<i>Platanus occidentalis</i> .
Tupelo gum	<i>Nyssa aquatica</i> .
Black walnut	<i>Juglans nigra</i> .
Black willow	<i>Salix nigra</i> .
Yellow poplar	<i>Liriodendron tulipifera</i> .

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MAY 1, 1927

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